MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2018/2019

PEL0016 – ELECTRICITY AND MAGNETISM

(Foundation in Engineering)

27 MAY 2019
2:30 P.M. - 4:30 P.M.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 5 printed pages including the cover page, physical constants and formula list.
2. Attempt **ALL** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

ANSWER ALL QUESTIONS

QUESTION 1 (15 MARKS)

a) **Figure Q1(a)** shows a trajectory of an electron which undergoes a uniform circular motion in a uniform magnetic field. The direction of the magnetic field is perpendicular to the page of the paper. The electron enters the magnetic field horizontally at point *A* with a speed of $v = 3.2 \times 10^5$ ms^{-1}.

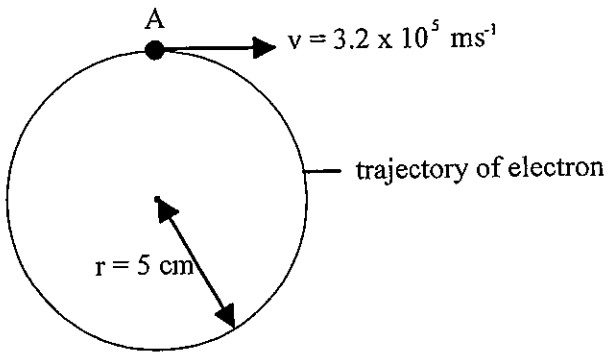

Figure Q1(a)

(i) Determine the magnitude and direction of the uniform magnetic field. [3 marks]

(ii) What is the time period of the motion? [2 marks]

(iii) If the speed of the electron at point *A* is increased, what will happen (if any) to the time period of the motion? Explain your answer. [2 marks]

b) A circular metal ring is suspended above a solenoid. The magnetic field due to the solenoid is shown in **Figure Q1(b)**. The current in the solenoid is increasing.

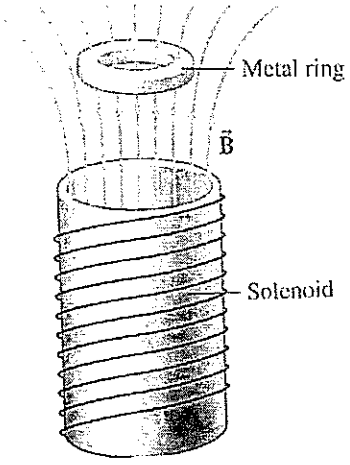

Figure Q1(b)

Continued...

(i) Determine the direction of the induced current in the ring.

[1 mark]

(ii) The magnetic flux through the ring is proportional to the current in the solenoid, $\Phi_B = kI$, where k is the constant of proportionality. When the current in the solenoid is 10.0 A, the magnetic flux through the ring is 0.35 Wb. When the current increases at a rate of 200 A/s, calculate the induced EMF in the ring.

[3 marks]

(iii) Is there a net magnetic force on the ring? If so, determine the direction of the net magnetic force.

[1 mark]

(iv) If the ring is cooled by immersing it in liquid nitrogen, what happens to its electrical resistance, the induced current, and the magnetic force? The change in the size of the ring is negligible.

[3 marks]

QUESTION 2 (15 MARKS)

a) Two wires P and Q are made of the same type of metal. P has length half of Q and its diameter is twice of that Q. Calculate the ratio of the resistance of P to resistance of Q.

[3 marks]

b) For the circuit shown in **Figure Q2(b)**,

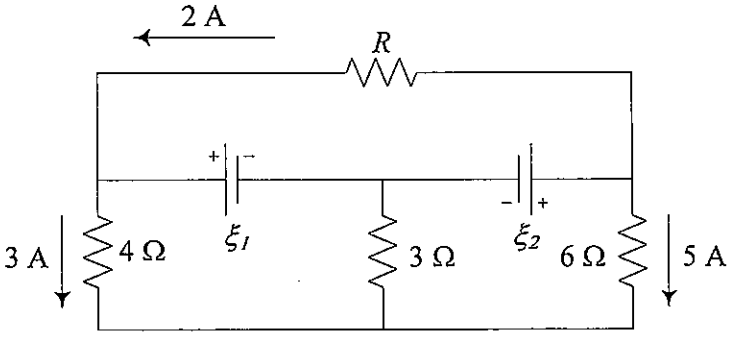

Figure Q2(b)

determine the following,

(i) the resistance R, [2 marks]

(ii) the current flows through ξ_1, [2 marks]

(iii) the current flows through ξ_2, [2 marks]

(iv) the current in the 3-Ω resistor, [2 marks]

Continued...

(v) the unknown EMF ξ_1, and [2 marks]

(vi) the unknown EMF ξ_2. [2 marks]

QUESTION 3 (10 MARKS)

A coil of inductance 160 mH and resistance 30 Ω is connected in series with a 60 Ω resistor to a 240 V, 50 Hz supply. Calculate:

a) the impedance of the circuit [2 marks]

b) the current in the circuit [2 marks]

c) the phase angle of the circuit [2 marks]

d) the voltage drop across the 60 Ω resistor [2 marks]

e) the voltage drop across the coil. [2 marks]

QUESTION 4 (10 MARKS)

a) What is ***doping***? [2 marks]

b) Explain the formation of n-type and p-type semiconductors with the aid of diagrams. [4 marks]

c) Sketch diagrams to show how a ***pn*** junction can be reverse-biased and forward-biased. [2 marks]

d) Explain the changes on the depletion regions when a ***pn*** junction is forward-biased and reverse-biased. [2 marks]

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APPENDIX 1

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	9.11×10^{-31} kg
Proton mass,	m_p	1.67×10^{-27} kg
Elementary charge	e	1.602×10^{-19} C
Gravitational constant	G	6.67×10^{-11} N.m^2 /kg^2
Gas constant	R	8.314 J/K.mol
Hydrogen ground state	E_o	-13.6 eV
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Compton wavelength	λ_c	2.426×10^{-12} m
Planck's constant	h	6.626×10^{-34} J.s
Speed of light in vacuum	c	3.0×10^8 m/s
Rydberg constant	R_H	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	9.81 m /s^2
Atomic mass unit (1u)	u	1.66×10^{-27} kg
Avogadro's number	N_A	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing	I_o	1.0×10^{-12} W /m^2
Coulomb constant	k	8.988×10^9 N m^2 /C^2
Permittivity of free space	ε_o/κ_o	8.85×10^{-12} C^2/N.m^2
Permeability of free space	μ_o	$4\pi \times 10^{-7}$ H/m

Energy equivalent of atomic mass unit:

One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

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APPENDIX II

List of formulas

$$A_v = \frac{V_c}{V_b}$$

$$\alpha_{dc} = \frac{\beta_{dc}}{\beta_{dc}+1}$$

$$\beta_{dc} = \frac{\alpha_{dc}}{1-\alpha_{dc}}$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \mu_0 nI$$

$$\xi = V + Ir$$

$$\xi = blv$$

$$\xi = -N\frac{\Delta\Phi}{\Delta t}$$

$$\xi = -L\frac{dI}{dt}$$

$$\xi = -M\frac{dI}{dt}$$

$$F = BIL\sin\theta$$

$$F = qvB\sin\theta$$

$$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$I_{tot} = \sqrt{I_R^2 + (I_L - I_C)^2}$$

$$I = neA(v_n + v_p)$$

$$I = nev_d A$$

$$I = I_{max}\sin\omega t$$

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$

$$I_x = \left(\frac{R_T}{R_x}\right)I_T$$

$$L = \frac{N\Phi_B}{I}$$

$$L = \frac{\mu_o N^2 A}{l}$$

$$M = \frac{N\Phi_B}{I}$$

$$M = \frac{\mu_o N_1 N_2 A}{l}$$

$$P = IV = I^2R = \frac{V^2}{R}$$

$$P_t = I_{rms}V_{rms}\cos\phi$$

$$P_r = V_{rms}I_{rms}\sin\phi$$

$$P_a = I_{rms}^2 Z$$

$$R = \frac{\rho L}{A}$$

$$R = R_0[1+\alpha(T-T_0)]$$

$$R_T = R_1 + R_2 + R_3 + \ldots$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

$$r = \frac{mv}{Bq}$$

$$\tau = NBIA\sin\theta$$

$$U = \frac{1}{2}LI^2$$

$$U = \frac{1}{2}B^2 A\frac{l}{\mu_o}$$

$$V_H = Bvd$$

$$V = V_{max}\sin\omega t$$

$$V_{rms} = \frac{V_{max}}{\sqrt{2}}$$

$$V_x = \left(\frac{R_x}{R_T}\right)V_S$$

$$X_C = \frac{1}{2\pi fC}$$

$$X_L = 2\pi f L$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\oint B.dl = \mu_o I$$

$$d\mathbf{B} = \frac{\mu_O I}{4\pi}\frac{d\ell\times\hat{\mathbf{r}}}{r^2}$$

$$\Phi_B = BA\cos\theta$$

$$\cos\phi = \frac{R}{Z}$$

$$\tan\phi = \frac{X_L - X_C}{R}$$

End of paper.